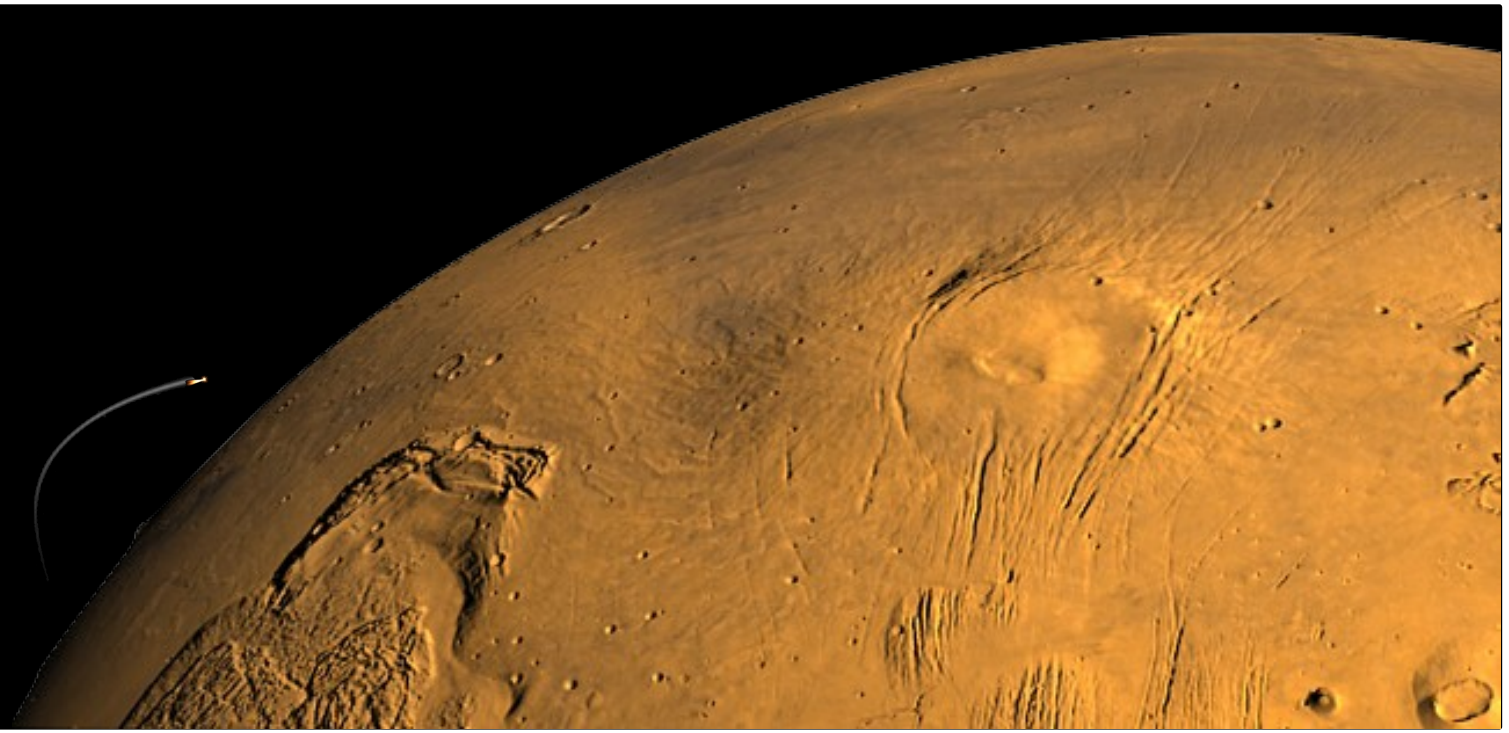
Mars Ascent Vehicle



Jet Propulsion Laboratory
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MARSHALL
SPACE FLIGHT CENTER

www.nasa.gov

Presentation to Powell County High School
Introduction

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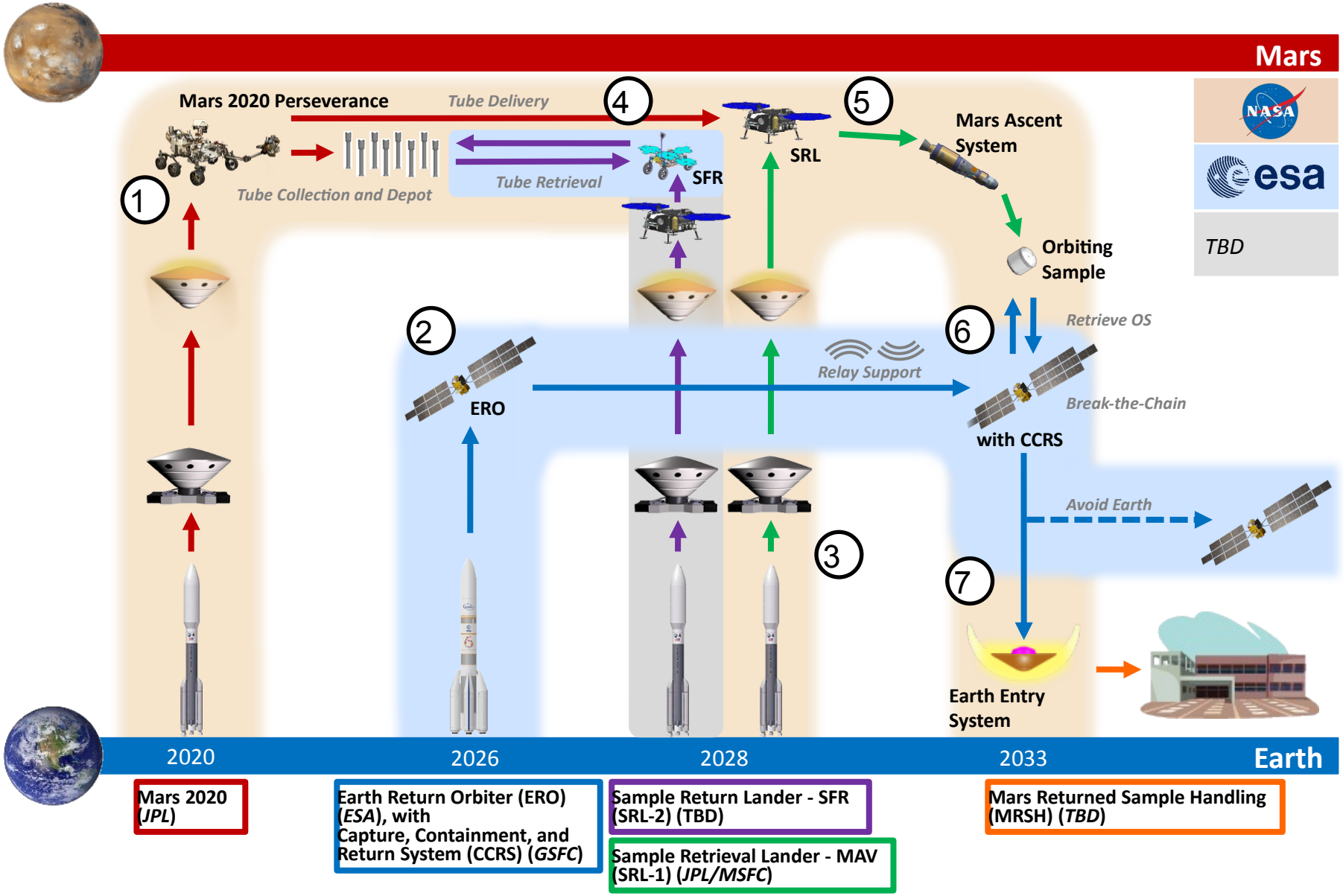
MSR Mission Overview

MSR Mission Objective:

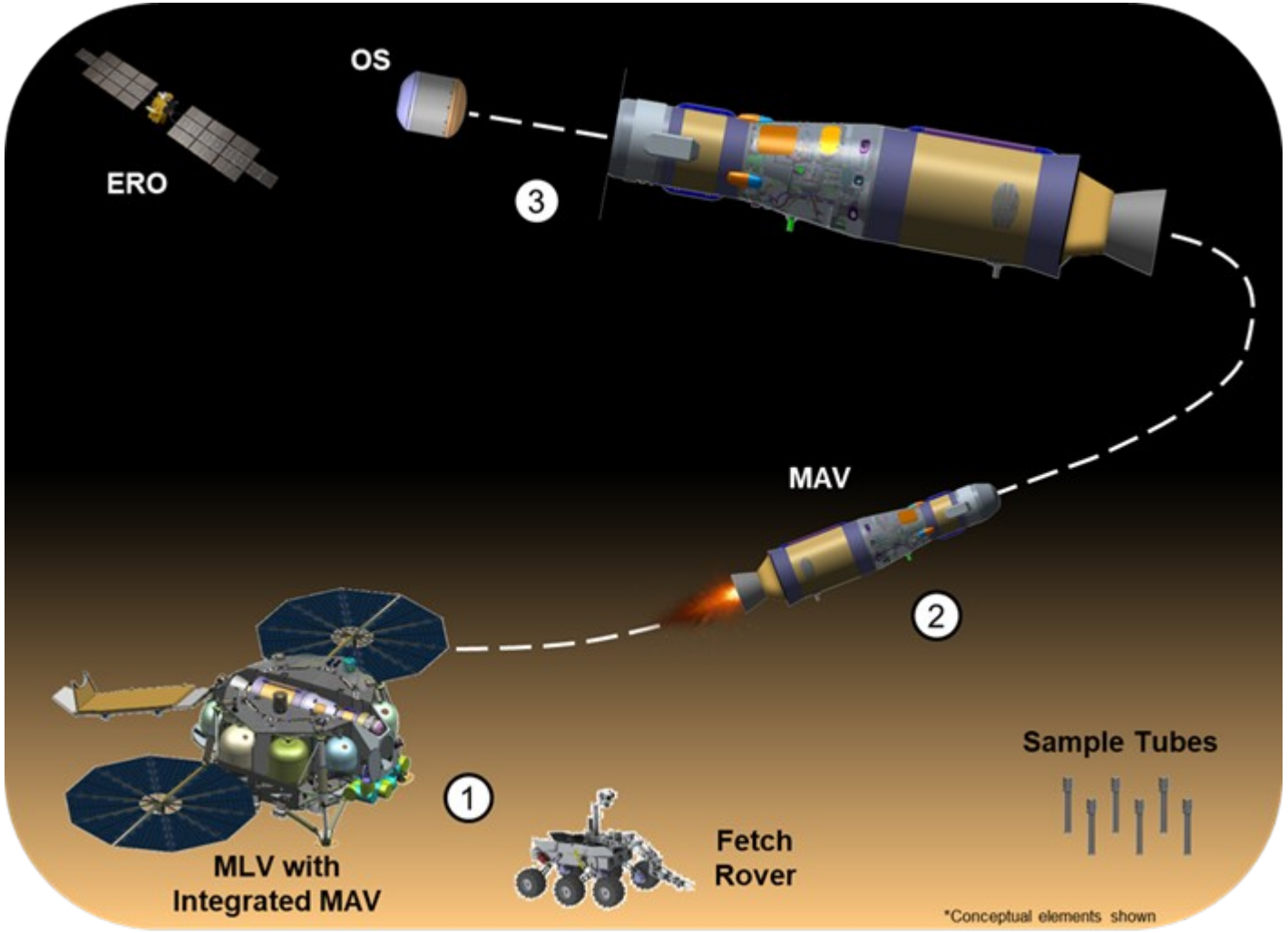
Retrieve Mars samples and return to Earth.

1. Mars 2020 rover collects Mars samples and leaves tubes in place.
2. Earth Retrieval Orbiter (ERO) sent to Mars orbit.
3. Mars Lander Platform (MLP) with Mars Ascent Vehicle (MAV) sent to Mars.
4. Fetch rover tasked with retrieving sample tubes on Mars surface.
5. MAV is loaded with the Orbiting Sample (OS) containing the sample tubes. MAV carries the OS to Mars orbit.
6. ERO rendezvous with OS, retrieves OS, and returns OS to Earth.
7. Earth Entry Vehicle returns OS to Earth's surface.

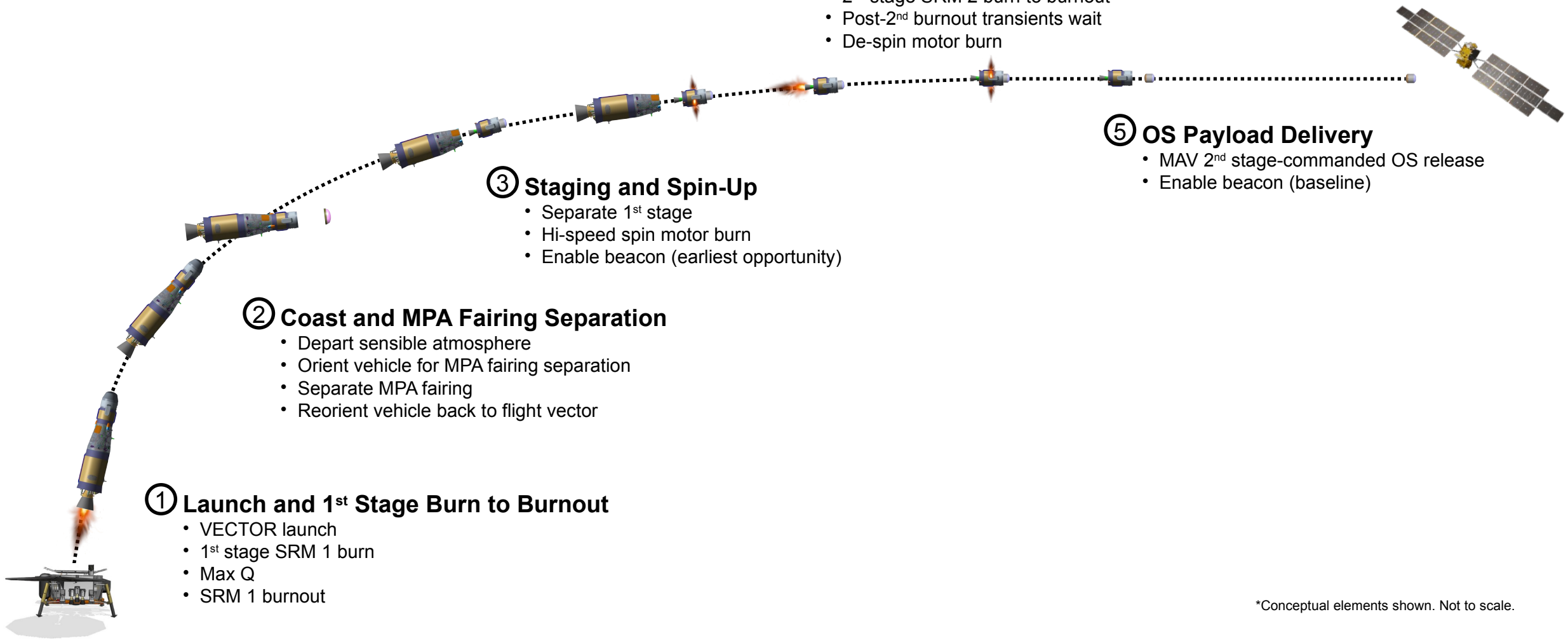


MAV Mission Objectives

1. Receive sample tubes inside OS on Mars surface.
2. Launch OS to predefined Mars orbit.
3. Release OS in Mars orbit.



MAV Ascent Mission Operations Overview



① Launch and 1st Stage Burn to Burnout
- VECTOR launch
- 1st stage SRM 1 burn
- Max Q
- SRM 1 burnout

② Coast and MPA Fairing Separation
- Depart sensible atmosphere
- Orient vehicle for MPA fairing separation
- Separate MPA fairing
- Reorient vehicle back to flight vector

③ Staging and Spin-Up
- Separate 1st stage
- Hi-speed spin motor burn
- Enable beacon (earliest opportunity)

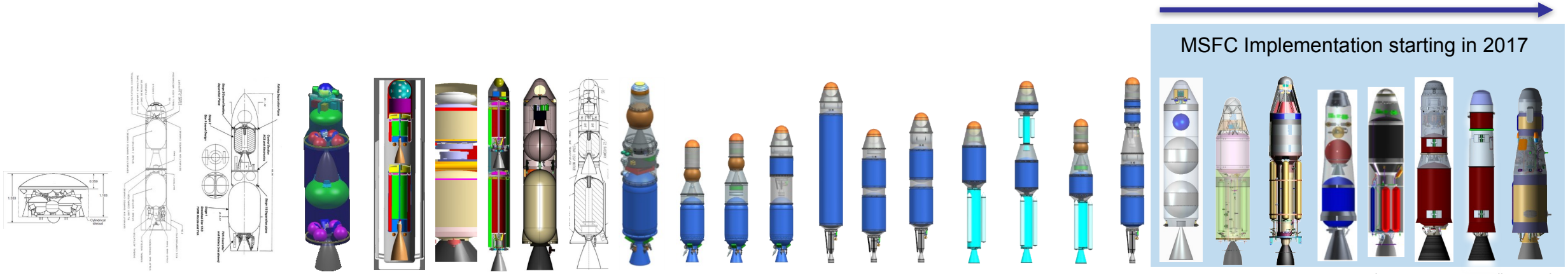
④ 2nd Stage Burn to Burnout and Spin-Down
- 2nd stage SRM 2 burn to burnout
- Post-2nd burnout transients wait
- De-spin motor burn

⑤ OS Payload Delivery
- MAV 2nd stage-commanded OS release
- Enable beacon (baseline)

*Conceptual elements shown. Not to scale.

1st Burn	Coast, Staging and Spin-Up	2nd Burn and Spin-Down	OS Release	Loiter
~78s	~374s	~22s and ~Minutes	~Minutes	~Days

MAV Concept History



Images not necessarily to scale

- MSFC's initial assessments considered:
  - Hybrid propulsion system – low GLOM, high performance in Martian environment (low TRL)
  - Solid propulsion system – energy management mitigates orbital dispersion (high TRL)
  - Liquid second stage – challenges meeting power and mass constraints

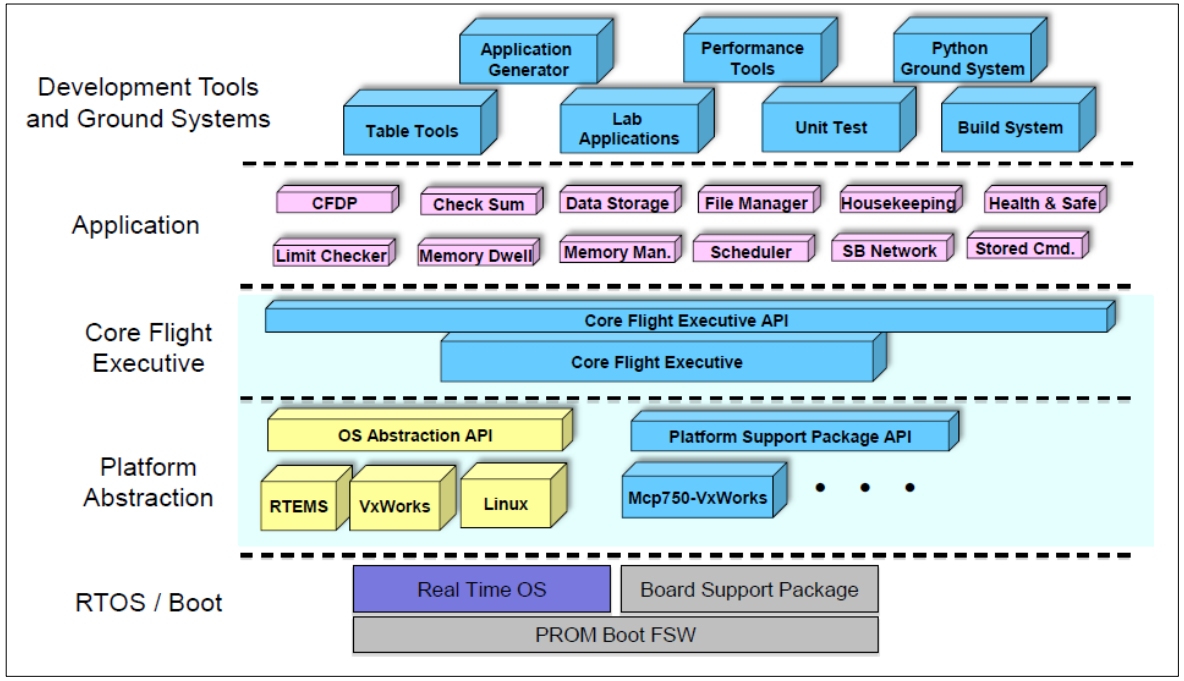
- Solid Propulsion Concept Enabled by:
  - Selection of Jezero Crater as landing site
  - Surface operations timeframe for MLV
  - Environmental constraints -40 C

- Preliminary Architecture Assessment confirmed Solid Propulsion Design
  - Solid propulsion design met cost, schedule and technical performance requirements

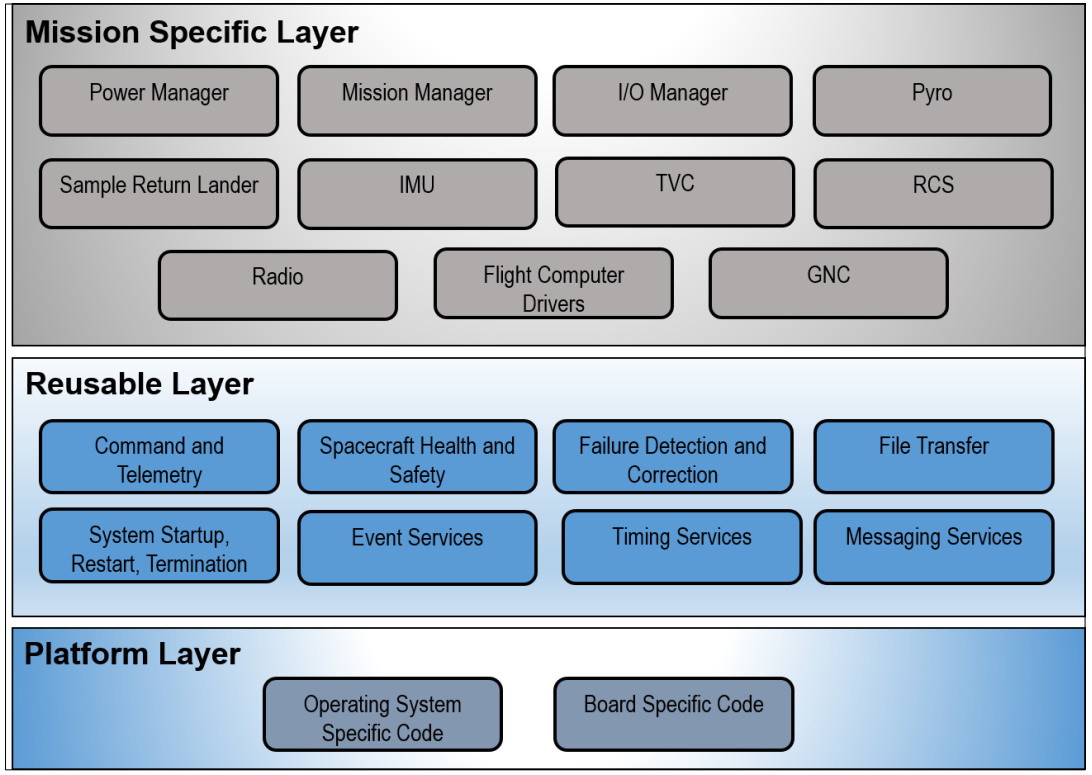
FSW Design - Layered Architecture

- FSW is designed using the cFS layered architecture.
- Each layer communicates with layers that are above and below it.

cFS Layered Architecture



MAV FSW Layered Architecture



- https://www.youtube.com/watch?v=IAj9tXZyqS8
- https://mars.nasa.gov/people/?category=all
- https://www.nasa.gov/centers/marshall/home/index.html

- https://www.nasa.gov/careers

- https://www.nasa.gov/careers/pathways